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ABSTRACT

Research on notetaking as a learning strategy and on the related techniques of outlining and concept mapping is reviewed. The effectiveness of these techniques in helping the learner encode new information and their usefulness in interactive multimedia instruction are explored. Research strongly supports an external-storage function of notetaking and suggests that notetaking supports encoding. Outlining has been shown to result in improved recall of facts, although significant training is required for successful use. Research also supports the usefulness of concept mapping. Integrating these strategies into interactive multimedia instruction can be done in several ways. Notebook approaches seem to be among the most effective. The complexity of notebooks can vary from simple copying through a hierarchy of sophistication from spatial mapping to the creation of a multimedia presentation by the student. Regardless of the complexity of the notebook incorporated, there is a need to teach how to use the learning strategy. Unless the strategies are used and understood, they will be considered burdensome and will probably not be used. (Contains 62 references.) (SLD)

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Title:

The Integration of Learning Strategies in Interactive Multimedia Instruction

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Introduction

A perplexing assortment of uses of the term "multimedia" abounds in the literature, variously describing computer-driven devices, computer programs, and combinations of the two, all of which are capable of producing mixtures of sound, graphics, animation and video. Schroeder (1991) describes "interactive" multimedia broadly as a hybrid technology merging various types of media with the computer. McCarthy (1989, p. 26) provides more detail, defining it as "the integration of text, audio, graphics, still image and moving pictures into a single, computer - controlled, multimedia product." Gayeski (1993, p.4) defines multimedia in terms of systems, as "a class of computer-driven, interactive communications systems which create, store, transmit, and retrieve textual, graphic, and auditory networks of information", while Schwier and Misanchuk (1993, p. 6), to place the emphasis on the computer program rather than hardware, describe interactive multimedia *instruction* as "an instructional program which includes a variety of integrated sources in the instruction with a computer at the heart of the system." Whatever the specific definition, such systems provide the possibility of nearly unlimited combinations of digitized audio, graphics and text, analog and digitized video, accessed through the computer itself and/or a variety of peripheral devices such as videodisc players, compact disc players and music synthesizer. They have the potential to utilize new developments in data-storage (laserdisc, compact disc, digitized video and audio), ever-increasing computer speeds and capabilities, and sophisticated software tools to allow a learner to move through a rich, multimedia base in a way that fits his/her own learning needs and preferences (Schroeder, 1991).

Interactive multimedia instruction can be linear and/or structured or more non-linear, resembling a database incorporating multiple formats. The organization of the information in a tightly structured program, those designed for a specific instructional purpose or objective, is generally very clear. Programs such as Eduquest's Stories and More, a literature- based curriculum system, offer information in multiple formats (digitized audio, graphics, text), allowing the learner choices, but still guide the user in a structured fashion. However, many of the newest programs, such as IBM's Illuminated Manuscripts and Intellimation's Letter from Birmingham Jail are more open-ended, with the structure of the information less obvious to the user. These resemble multimedia databases where the user selects the path, information, and format to view.

Interactive Multimedia and Instruction

Romiszowski (1990) defines instruction as a goal-oriented teaching process that is based on pre- planning and formative evaluation. He views hypermedia [an alternate term for non-linear interactive multimedia instruction] as independent of specific goals and instructional objectives, as possibly a component of an instructional system, but functioning separately as an informational system. Duchastel (1990) claims hypermedia is better suited to informal learning than formal instruction; a learning rather than a teaching tool. Thus, " [A]ny structure imposed upon the situation in order to enhance the learning experience to be derived from it is really extrinsic to hypermedia itself" (Duchastel, 1990, p. 139). Structure in hypermedia may actually inhibit user interest and, hence, exploration. Associational learning is an appropriate use of hypermedia.

This is consistent with a constructivist view of learning which holds that the learner individually constructs knowledge through interpreting perceptual experiences of the external world (Jonassen, 1991). Learners develop unique associations between prior knowledge stored in long term memory structures and new information. This encoding may involve the integration

of information into existing schemata (assimilation) or the construction of new schemata (accommodation). Constructivists encourage inductive, or discovery, learning in which learners engage a domain and "construct their own concepts and rules based on their interpretation of the instances encountered" (Rieber, 1992, p.96). Learning occurs through interactions with one's environment or culture and the potential for learning increases as the instructional situation becomes richer and more engaging for the learner. From a constructivist point of view, it is important that learning environments provide learners with experience in and appreciation for multiple perspectives, encourage multiple modes of representation, and embed learning in realistic and relevant contexts which support intrinsically motivating and self-regulated learning (Rieber, 1992, McMahon, Carr & Fishman, 1993).

Interactive multimedia instruction can provide the rich learning environment central to a constructivist view of learning by furnishing databases of information in multiple formats and perspectives and which nurture incidental learning. However, such environments necessarily provide a limited amount of structure and require learners to create their own. How can designers help learners to construct meaning in such environments? Learners may benefit from strategies that help them encode the information they encounter in interactive multimedia instruction, strategies such as paraphrasing, generating questions, outlining, cognitive mapping, creating images and summarizing. These activities could be supplied by the instructional system or generated by the learner.

Learning Strategies to Facilitate Encoding

Learning strategies have tended to be explained in terms of information-processing theory rather than constructivism. Bruning (1983, p. 93) defines learning strategies as "any internally or externally mediated cognitive process that will facilitate transfer of information to be learned from short-term into long-term memory". Information-processing theory holds that short term memory has a limited processing capacity such that learners are forced to select from all possible information presented for processing. Short term memory holds information for only seconds before it is lost or encoded for storage in long term memory. Learning strategies are generally called into use at this point to facilitate the transfer of information (Bruning, 1983).

Weinstein and Mayer (1986) also link learning strategies to encoding. Based on Cook and Mayer's (1983) analysis of the encoding process, they describe encoding as comprised of four components: a) *selection* - the learner actively pays attention to some of the information impinging on sense receptors and transfers it to working memory; b) *acquisition* - the learner actively transfers information between working and long-term memory for further study; c) *construction* - the learner actively builds internal connections between ideas in the information that reaches working memory; and d) *integration* - the learner actively searches long-term memory for prior knowledge and transfers it to working memory to construct external connections with the new information.

Learning strategies are used to rehearse, organize, and elaborate information to make it more meaningful. Strategies include underlining and repetition for rehearsal; outlining, categorization, and mapping for organization; and mental imagining, forming analogies, inserted questions, paraphrasing and analyzing key points for elaboration. Rehearsal strategies help focus attention on important information and encode it in short term memory (selection and acquisition), while organization strategies help in selecting appropriate information and constructing connections among the ideas (construction). Elaboration strategies help transform information by making the material more meaningful and building connections among new ideas and prior knowledge.

This paper will overview the research on perhaps the most widely used learning strategy, notetaking, and on two related techniques, outlining and concept mapping. It will provide an analysis of their effectiveness to aid the learner in encoding new information, examine current uses of these strategies in interactive multimedia instruction, and offer suggestions for the incorporation of these learning strategies into future designs.

Notetaking and Related Learning Strategies

Historically, much of the research has focused on notetaking from oral or videotaped lectures (Hartley & Davies, 1978, Carrier & Titus, 1979, Rickards, 1979, Kiewra, 1985, 1987). Only recently have studies begun to focus on notetaking from text (Kiewra, DuBois, Christensen, Kim & Lindberg, 1989; Wade & Trathen, 1989). Two hypotheses have been advanced to explain the potential effectiveness of notetaking to facilitate learning: 1. notetaking assists encoding or 2. notetaking provides a product which can be reviewed later (Divesta & Gray, 1972, cited in Rickards, 1979).

The encoding hypothesis or process function of notetaking

This hypothesis holds that notetaking is beneficial, independent of review, because it increases attention during the lecture and facilitates encoding of lecture ideas into long term memory (Kiewra, 1985, 1987, Hartley & Davies, 1978). Peper & Mayer (1986) advance three sub-hypotheses to explain why the encoding hypothesis may or may not be true. The first two are based on how much is learned while the third focuses on the degree to which the learner is able to actively relate material to existing knowledge. The first, the Attention Hypothesis, states that notetaking facilitates learning by forcing the learner to pay more attention to presented material or to process presented material more deeply. Notetakers would perform better than non- notetakers on dependent measures. The second, the Distraction Hypothesis, holds that notetaking impedes learning by forcing the learner to concentrate on the motor act of writing instead of more fully listening to lecture. Notetakers would perform worse than non- notetakers on dependent measures. The third, the Generative Hypothesis (Wittrock, 1974), is based on idea that notetaking helps the learner to generate meaning by relating presented information to prior knowledge and thus building a more integrated learning outcome. Notetakers are expected to perform better than non- notetakers on far transfer tasks but worse on near transfer tasks.

The external storage or product function of notetaking

This hypothesis holds that notetaking is beneficial because the notes comprise a tangible product which can be retrieved and used once the instructional event has passed. Rickards (1979) suggests two possible functions for the external storage idea:

1.) a Rehearsal Function: enhanced recall is only due to remembering material from the notes just reviewed (the notes provide the learner with more information).
2.) a Reconstruction Function: recall of notes allows learners to reconstruct parts of the passage on which no notes previously taken (the notes help the learner to recall other information).

The effectiveness of notetaking

The encoding hypothesis. Research evidence for this function is mixed. Combined findings (Kiewra, 1987) of review papers by Hartley & Davies (1978) and Kiewra (1985) reported 35 studies on notetaking from lectures supporting the encoding function, 23 indicating no significant differences between those who do and those who do not record notes and 3 indicating the activity of notetaking to be dysfunctional relative to listening only. For notetaking from text material, there is some evidence that notetaking served a minimal encoding function and may even have interfered with processing (Kiewra, DuBois, Christensen, Kim & Lindberg, 1989). Also, a study by Wade and Trathen (1989) indicated that noting information (including notetaking) has little effect, independent of the importance of the ideas noted, on the recall of that information.

The external storage hypothesis. Initial research findings appear to strongly support this function. Combined findings (Kiewra, 1987) of review papers by Hartley & Davies (1978) and Kiewra (1985) reported 24 studies on notetaking from lectures supporting the product function (those who reviewed their notes achieved more), 8 studies indicating no significant differences between reviewers and non- reviewers and no study indicating reviewing notes to be dysfunctional.

The rehearsal function of the external storage hypothesis. More recent evidence seems to support this explanation (Kiewra, DuBois, Christensen, Kim & Lindberg, 1989; Kiewra, DuBois, Christian, Mcshane, Meyerhoffer & Roskelly, 1991). These investigators indicate that, for these earlier studies, what has traditionally referred to as "external storage" has really been a combination of encoding and external storage because the latter group consisted of students reviewing their own notes. Learners had, in effect, two chances to process the information (a repetition effect). When "external storage" is reformulated as those who review notes but who have not previously viewed the lecture, the results appear less conclusive. In these two studies, the reformulated product function was shown to be less effective for factual recall and recognition than an encoding plus storage treatment condition, although not for higher order (synthesis) performance. Encoding only was consistently the least effective treatment and no more effective than listening to a lecture without notetaking. Thus, notetakers who review outperform notetakers who do not review.

Further, the encoding process per se (without review) did not appear to be aided by recording notes on linear or matrix frameworks (Kiewra, DuBois, Christian, Mcshane, Meyerhoffer & Roskelly, 1991). This is consistent with results from a study of fill- in versus completed graphic organizers (Kenny, 1992) used with interactive video where the notetaking treatment appeared to interfere with, rather than facilitate, learning from the program. In fact, when learning from text was tested, students who read twice from the material but did not take notes outperformed those using any form of notetaking (Kiewra, DuBois, Christensen, Kim & Lindberg, 1989). Further, Anderson's (1980) reanalysis of a study by Arnold (1942) found that simply rereading a passage was more influential on recall than more obtrusive techniques such as outlining which he hypothesized might actually be detrimental. Other studies comparing notetaking to repetitive reading (Hoon, 1974; Dynes, 1932; Stordahl and Christensen, 1956) found notetaking no different from reading alone. Notetaking, whether from lecture or text, may be a sufficiently demanding process that relatively little encoding actually occurs during the act of notetaking (Kiewra, DuBois, Christian, Mcshane, Meyerhoffer & Roskelly, 1991; Kenny, 1992). Also, evidence further contradicting the efficacy of the product function is that students' notetaking is generally incomplete (Kiewra, 1987, Kiewra, DuBois, Christian, Mcshane,

Meyerhoffer & Roskelly, 1991). The review of instructors's notes provides best results (e.g. Kiewra, 1985, Kiewra & Frank, 1988; Risch & Kiewra, 1990) although student notes improve with repetition (Kiewra, Mayer, Christensen, Kim & Risch, 1991).

Outlining

Outlining is defined as "a high level skill which involves identifying relationships between concepts and arranging those concepts in an order which demonstrates the superordinate and subordinate nature of the concepts involved" (Anderson-Madaus, 1990, p. 3). Outlining: a) causes focusing on important points, b) helps students gain familiarity with text structure, c) aids retention, d) generates useful alternative texts to supplement materials read, and e) causes active participation in learning (Bianco and McCormick, 1989).

The effectiveness of outlining. Several studies have shown that outlining results in improved recall of facts (Barton, 1930, Annis and Davis, 1975; Glynn and DiVesta, 1977; Shimmerlik and Nolan, 1976). The use of hierarchical summarization strategy, a form of outlining, improved comprehension and recall in the middle school students (Taylor and Beach, 1984), while ninth-graders who completed an outline grid when reading did better on multiple choice recall tests (Slater, Graves, and Piche, 1985). Further, research asking students to generate outlines provides some support for their facilitation of recall. Outlining, if done properly (e.g. focusing on main ideas, organizing from abstract to concrete in the hierarchy, working from a classification of concepts) and not viewed as being too intrusive in the study process, can aid in both organizing new information and integrating new knowledge into one's personal knowledge structure (Hoffler, 1983; Anderson, 1980). For example, Tuckerman (1993) studied coded elaborative outlines, a method which involves outlining chapters, coding the main points using a six-code scheme, and adding elaborations of main points, such as examples and explanations. College students who were required to create coded elaborative outlines of chapters performed significantly better than students who did so voluntarily, who created standard outlines, or who did not outline (Tuckerman, 1993). Students given the option of outlining generally chose not to do so, but those not required to write these outlines performed better the more they outlined.

Outlining has also been compared to other learning strategies. Palmatier (1971) found that college students using outlining had the highest level of essential content in their notes compared to those using a three-column method, the Bartush Active Methods or no method, while Snyder (1984) found a significantly higher recall performance for the outlining method in a study comparing the use of SQ3R, outlining, and underlining to study college textbooks. Iovino (1989) found that outlining significantly helped college students to achieve higher immediate recall than did networking, but networking significantly improved their ability to retain information over time. Students were given five hours of training in the technique they used. In a study of the use of outlining and clustering in prewriting (Kellogg, 1990), outlining was most beneficial when only the topic was provided and students had to generate and organize ideas, but did not help if the topic, ideas, and organization were given.

Other studies report no advantage of outlining over other strategies (Arnold, 1942; Stordahl and Christensen, 1956; Todd and Kessler, 1971; Willmore, 1966 cited in Iovino, 1989) or a marginal advantage for outlining in writing papers (Branthwaite, Trueman, and Hartley, 1980; Emig, 1971). Emig (1975) found no correlation between creation of an outline and organization of a written theme.

Training Needed in Outlining. Anderson (1980) notes that outlining, like strategies such as imaging and paraphrasing, requires a major intrusion in the reading processes and also necessitates a significant amount of training to use properly. In research on student-generated

study aids, he found, that without explicit instruction in the use of the aid, students do as well simply rereading the assignment. Outlining is often one of the only strategies taught in the middle grades and is the strategy preferred by students (Bean, Singer, Sorter & Frazee, 1983). Training to outline is done in most schools, but often not in a way that students understand it conceptually. Matott (1987) claims that few students have been taught that outlining requires the identification of major points, then all sub-major points and so on. Hoffler (1983) stresses the need to present an outline as moving from abstract to concrete as one goes down the hierarchy. To do this he suggests students must work backwards, classifying from concrete items to more abstract concepts.

Spatial notetaking strategies

An outgrowth of schema theory (Kiewra, 1988) is the study of learning strategies involving the reorganization of linear information into a spatial representation that specifies relationships among concepts. The process of creating a spatial arrangement requires a relatively deep level of processing aimed at determining internal connections among ideas. Kiewra & his associates (Kiewra, DuBois, Christensen, Kim & Lindberg, 1989; Risch & Kiewra, 1990; Kiewra, DuBois, Christian, Mcshane, Meyerhoffer & Roskelly, 1991) have developed and tested a modified form of spatial notetaking strategy which supplied learners with a matrix already containing horizontal and vertical headings from the presentation. Results from four experiments varied. The investigators found no significant advantages for matrix notetaking in three studies. A significant difference in favor of the technique compared to conventional notetaking - when students were allowed to review their notes - was found in the fourth study.

Concept Mapping

Perhaps the most widely known and researched spatial learning strategy is concept mapping (Novak, Gowin & Johansen, 1983; Novak & Gowin, 1984, Heinze-Fry & Novak, 1990; Novak, 1990). Concept mapping was developed as a spatial knowledge representation technique based on Ausubel's Theory of Meaningful Learning, a theory which holds that knowledge in memory is hierarchical, with more general, more inclusive concepts subsuming progressively less inclusive, more specific ones (Novak & Gowin, 1984). Concept maps, then, are drawn hierarchically, with more inclusive concepts at the top of the map and progressively more specific ones arranged below. Concepts are placed in ovals and linked by labelled lines to form semantic units termed propositions.

Concept maps are viewed, first and foremost, as a tool for negotiating meanings. Maps are constructed in collaboratively by the instructor and the learner(s). However, it can also be used as a pre-instructional tool in the form of an advance or graphic organizer and as a notetaking technique for extracting key concepts from printed or oral material (Novak & Gowin, 1984).

The effectiveness of concept mapping. A recent meta-analysis of nineteen studies (Horton, McConney, Gallo, Senn & Hamelin, 1993) provides an overview of the general effectiveness of the technique. Studies had to occur in an actual classroom and use concept mapping as an instructional tool compared to an alternate technique as a control. Nearly all studies examined involved science content, material which could be argued lends itself to a hierarchical depiction. in 15 of the 19 studies, the students prepared the maps. Effect sizes (E.S.) for achievement ranged from -0.31 to + 2.02 with a mean E.S. of 0.46. For measures of student attitude towards the particular subject matter, E.S.'s ranged from 0.05 to 4.88 with a mean E.S. of 1.57. The investigators concluded that concept mapping has generally medium positive effects on achievement and large positive effects on attitude.

Research results also indicate that the primary benefit of concept mapping accrues to the person who constructs the map (Novak, 1990; Horton et al, 1993), that teacher-prepared maps may be helpful to students, but only after they have had practice preparing their own maps and that, at first (for 2-4 weeks), there is generally an average *decline* in performance for strategies that require meaningful learning although they finish up significantly higher (Novak, 1990). The implication is that time is needed for students to learn and learn to appreciate meaningful learning strategies such as concept mapping.

Integrating Learning Strategies in Interactive Multimedia Instruction

Interactive multimedia instruction has many capabilities to facilitate encoding. It can provide a variety of practice strategies with feedback depending on learner choices, provide learner guidance in terms of recommended paths, incorporate multimodal techniques, and provide active manipulation of lesson content for interaction and resolution of conflicting information. Current interactive multimedia instruction often takes the form of a multiple format database. In many systems, learners are guided to manipulate the lesson content through notetaking. The learner is able to open a notetaking screen by clicking a button, type in notes about the current topic being explored, or copy sections from different screens into the notebook, and either print or save these notes to disk. Guidance on taking notes is rarely given. This presents a problem since learners frequently do not incorporate structure in their notetaking or fail to elaborate on the new information. Since research has indicated that students are generally incomplete note-takers (Kiewra, 1987, 1988), this may represent a serious design flaw. A number of notetaking techniques have been proposed which could be incorporated into interactive multimedia to enhance learner encoding in a more structured fashion. These include linear approaches like outlining (Kiewra, DuBois, Christian & McShane, 1988) and spatial learning strategies such as concept maps (Novak and Gowin, 1984).

Programs with notebooks or notepads are often fairly rudimentary. If they are used by students they risk replicating the same shortcomings of notetaking, outlining and mapping on paper. The computer offers capabilities that might be used to incorporate the best aspects of each of these learning strategies while avoiding some of their pitfalls. It also offers the ability to offer a degree of guidance to the user if necessary or if desired by the instructor. Capabilities that might be exploited in incorporating learning strategies into a notebook include:

- cutting, pasting and manipulating text and media (graphics, sound, video - e.g. pasting in Quicktime/ Video for Windows movie into a word processing document). This could be done in outline or spatial map format using text and/or icons.
- using screen titles and/or topics to organize information and the ability to connect and manipulate these, pull them together into a concept map or hypermap. This could be done in outline or spatial map format using text and/or icons.
- creating a multimedia document from information gathered.

Kozma (1987) has also proposed the electronic notebook idea. Computers can aid the learning process by a) supplementing working memory, b) making relevant prior information available quickly, c) prompting the learner to connect, integrate, and structure new information with old in an easily changeable manner, and d) providing both verbal and visual representations. Learning Tool by Intellimation for the Macintosh computer is an example of a program that presents the learner with blank workspaces and tools to develop key points,

connect them in networks, and provide textual and graphic information about each. The program cues, evokes, models, and supplements the learner's thought processes. in effect, it provides a tool for concept mapping and related spatial notetaking techniques.

Outlining in a computerized environment can add several new features. Students can incorporate text as well as various other media types in a outline, by either cutting and pasting or linking to external resources. When using a interactive multimedia program, all the information can be included, no matter what the format. Applications such as Mediatext, WordPerfect and Microsoft Word already offer these features.

Many word processors also offer the ability to expand and compress outlines. If this feature were incorporated into a program's notebook, students could view their information at different levels of the hierarchy, e.g. degree of abstraction or detail. If the designer or instructor desires, he/she could provide an intact outline in which to take notes and include media, acting as guide through the system and showing one view of the overarching structure in a linear, hierarchical fashion. Students might chose to view or not to view this as desired. Different outlines might be available to show different perspectives on the interactive multimedia system's information.

Types of notebooks

The design of notebooks for interactive multimedia systems can incorporate some or all of the features discussed previously. Their degree of sophistication can be thought of as a hierarchy with each level having its advantages and disadvantages. A possible hierarchy is described below. The forms of learning strategy involved, according to Weinstein`s and Mayer`s (1986) categories, are listed in parenthesis after each point.

1. Copy and paste text & graphics a whole screen or section at a time in the order found.

   Advantages:

   a. At the very least would create active involvement by the learner in the selection of relevant information, that is elicit generative learning (rehearsal, organization, elaboration).
   b. Multiple formats could be included in the notes (rehearsal, organization, elaboration).
   c. The accuracy of information could be guaranteed because it would be recorded exactly (rehearsal).

   Disadvantages:

   a. No depth of processing is required of the learner, making it much like underlining/highlighting.
   b. The learner is not encouraged to relate the new information to prior knowledge and to elaborate it in a personally meaningful way.
   c. Encourages external storage of information, but not necessarily encoding.
   d. The learner cannot show relationships among ideas. The information may have to be stored in the order selected and copied rather than reorganized in a personally meaningful way.
   e. May be difficult to get an overview of the organization of the information.

2. Copy and paste text and graphics selected in the order found.

Advantages:

a. Multiple formats could be included in the notes (rehearsal, organization, elaboration).
b. The accuracy of information could be guaranteed because it would be recorded exactly (rehearsal).
c. The learner could select only the information needed as it is found (rehearsal, organization).
d. The learner is more actively involved in selecting information to include, that is, generative learning (rehearsal, organization).

Disadvantages:

a. The learner is not encouraged to relate the new information to prior knowledge and to elaborate it in a personally meaningful way.
b. Encourages external storage of information, but not necessarily encoding.
c. The learner cannot show relationships among ideas. The information may have to be stored in the order selected and copied rather than reorganized in a personally meaningful way.
d. May be difficult to get an overview of the organization of the information.

3. Use headings in interactive multimedia to create hierarchy of an outline (i.e., the levels of hierarchy are embedded in headings themselves).

Advantages:

a. This would accurately show the hierarchy intended by the developer (organization).
b. If the learner can select which headings to include, he / she has the ability to create a unique structure of this information to a certain extent, that is, elicit generative learning (organization, elaboration).
c. The accuracy of the information could be guaranteed because it would be recorded intact from the program (rehearsal).

Disadvantages:

a. The hierarchy portrayed may not match the learner's prior knowledge or information need.
b. The learner cannot create his / her own relationships or reorganize the information in a personally meaningful way.
c. The learner is not encouraged to relate the new information to prior knowledge.
d. Encourages external storage of information, but not necessarily encoding.
e. If the learner cannot select the headings to include, superfluous information could be included.

4. Arrange and rearrange text and graphics copied from the program without adding additional information.

Advantages:

a. The learner can create his / her own categorizations/connections among ideas (organization, elaboration).
b. The learner can display his / her own conception of the relationships among the ideas, becoming actively involved in the integration of new information (organization, elaboration).
c. Multiple formats could be included in the notes (rehearsal, organization, elaboration).
d. The accuracy of information could be guaranteed because it would be recorded intact from the program (rehearsal).

Disadvantages:

a. There is no inherent way to show relationships; the learner must use text to relate the ideas.
b. May be difficult to get an overview of the organization of the information.

5. Add own text/graphics to information selected.

Advantages:

a. The learner can create his/her own categorizations/connections among ideas (organization, elaboration).
b. The learner can display his/her own conception of relationships among the ideas, becoming actively involved in the integration of new information (organization, elaboration).
c. Multiple formats could be included in the notes (rehearsal, organization, elaboration).
d. The learner can make the new information personally relevant through elaboration with prior knowledge (elaboration).
e. The learner can connect new information to prior knowledge (elaboration).
f. The learner could type in prior knowledge before going through the program, offering a framework to attach new information to (organization).
g. The learner or instructor could provide an initial framework or questions to act as an organizer for the new information (organization).
h. The learner can put information into his/her own words, facilitating encoding and retrieval cues (organization, elaboration).
i. The learner can add connection words or symbols to show relationships among the concepts (organization, elaboration).

Disadvantages:

a. There is no inherent way to show relationships; the learner must use text to relate the ideas.

b. May be difficult to get an overview of the organization of the information.
c. Information added may be inaccurately copied or connected.

6. Create an outline from information in the program and text/graphics added.

Advantages:

a. The learner can create his / her own hierarchical arrangement of the information (organization, elaboration).
b. The learner is actively involved in selecting information to be included, elaborating with prior knowledge, and integrating new and prior knowledge (organization, elaboration).
c. Multiple formats could be included in the notes (rehearsal).
d. The learner could type in prior knowledge before going through the program, offering a framework to attach new information to (organization).
e. The learner or instructor could provide an initial framework or questions to act as an organizer for the new information (organization).
f. The learner can put information into his/her own words, facilitating encoding and retrieval cues (organization, elaboration).
g. It may be easy to move this to actual student production.

Disadvantages:

a. Learners not trained in outlining may try to create outline in a linear fashion and not really develop hierarchy.
b. The outline format may in itself be cumbersome.
c. It may be hard to for the learner to see levels of hierarchy unless outline can be collapsed.
d. Not all information lends itself to a hierarchy.
e. It may be difficult to incorporate other media resources into the outline.
f. .nformation added may be inaccurate.

7. Creating a spatial map from information in the program.

Advantages:

a. The learner can create and see the hierarchy or connections visually (organization, elaboration).
b. The information included does not have to be hierarchical in arrangement (organization).
c. The learner may be able to hide layers of hierarchy as necessary (organization).
d. The learner may be able to create linkages among concepts and describe the nature of the relationships shown by the links (organization, elaboration).
e. The accuracy of the information could be guaranteed if it was recorded intact from the program (rehearsal).

Disadvantages:

a. Learners not accustomed to this techniques will require instruction in its use.
b. Not all students may be graphically oriented.
c. Additional information cannot be added to make it personally meaningful.

8. Spatial mapping with learner adding own text elaborations.

a. The learner can create and see the hierarchy or connections visually (organization, elaboration).
b. The information included does not have to be hierarchical in arrangement (organization).
c. The learner may be able to hide layers of hierarchy as necessary (organization).
d. The learner may be able to create linkages among concepts and describe the nature of the relationships shown by the links (organization, elaboration).
e. The learner can display his / her own conception of the relationships among new and old ideas, becoming actively involved in the integration of new information with prior knowledge (organization, elaboration).
f. The learner could type in prior knowledge before going through the program, offering a framework to attach new information to (organization).
h. The learner can put information into his/her own words, facilitating encoding and retrieval cues (organization, elaboration).

Disadvantages:

a. Learners not accustomed to this techniques will require instruction in its use.
b. Not all students may be graphically oriented.
c. Information added may not be accurately copied or connected.

9. Spatial mapping with adding own text / graphics elaborations and media resources from the program.

Advantages:

a. The learner can create and see the hierarchy or connections visually (organization, elaboration).
b. The information included does not have to be hierarchical in arrangement (organization).
c. The learner may be able to hide layers of hierarchy as necessary (organization).
d. The learner may be able to create linkages among concepts and describe the nature of the relationships shown by the links (organization, elaboration).
e. The learner can elaborate the spatial map with prior knowledge (organization, elaboration).
f. Multiple formats could be included in the notes (rehearsal, organization, elaboration)).
g. The learner could type in prior knowledge before going through the program, offering a framework to attach new information to (organization).

h. The learner or instructor could provide an initial framework or questions to act as an organizer for the new information (organization).
i. The learner can put information into his/her own words, facilitating encoding and retrieval cues (organization, elaboration).
j. The learner can add connection words or symbols to show relationships among concepts (organization, elaboration).

Disadvantages:

a. Learners not accustomed to this technique will require instruction in its use.
b. Not all students may be graphically oriented.
c. Information added may not be accurately copied or connected.

10. Creating a multimedia document / presentation.

Advantages:

a. The learner can create his/her own categorizations/connections among ideas (organization, elaboration).
b. The learner can display his/her own conception of relationships among the ideas, becoming actively involved in the integration of new information (organization, elaboration).
c. Multiple formats could be included in the notes (rehearsal, organization, elaboration).
d. The learner can make the new information personally relevant through elaboration with prior knowledge (elaboration).
e. The learner can connect new information to prior knowledge (elaboration).
f. The learner could type in prior knowledge before going through the program, offering a framework to attach new information to (organization).
g. The learner or instructor could provide an initial framework or questions to act as an organizer for the new information (organization).
h. The learner can put information into his/her own words, facilitating encoding and retrieval cues (organization, elaboration).
i. The learner can add connection words or symbols to show relationships among the concepts (organization, elaboration).

Disadvantages:

a. Learners not accustomed to this technique will require instruction in its use.
b. There is no inherent way to show relationships; the learner must use text to relate the ideas.
c. May be difficult to get an overview of the organization of the information.
d. Information added may be inaccurately copied or connected.

Design Considerations

When determining the type of notebook to include with a program, the designer much take into account the capabilities of the computer, the needs of the learners, and the research on notetaking strategies. Just copying and pasting in notebook is not likely to be any more effective than underlining or highlighting in a text. Research has shown no significant effect on recall from these techniques. Research on outlining and concept mapping offers suggestions for the designer.

Notetaking in an interactive multimedia system is not the same as notetaking in a lecture, because pacing not an issue in the computer program. Learners have time to copy text and elaborate, similar to underlining with margin notes or two-column notetaking, and then elaborate with their own text and graphics. They can organize or categorize information as they go along or after gathering all the information, due to the ease of cutting and pasting. They might also create a graphical representation of the information as they go along or after collecting all the information. Potential ease of expanding and collapsing outlines may make it easier for learners to perceive the structure of the information at various levels. Tuckerman's research on coded elaborative outlining provides a basis for this use of a notebook (Tuckerman, 1993).

Learners also need to have reason to use a notebook. Notetaking and other learning strategy research has shown that students prefer to merely read and reread information as their strategy of choice. Strategies such as concept mapping and outlining may not be in their repertoire of strategies. If they are aware of the strategy, they will tend to use those they feel most comfortable with, even if it may not be the best for the situation. A notebook may be provided, but not used. A notebook that provides some of the more sophisticated features may need introduction to the students or they may use it in a simple cut and paste mode. Such introduction may be available and/or guidance in the use of the notebook provided and then extinguished as the learner becomes more comfortable with its use.

Notetaking research has shown that learner who elaborate on the information interact more with the new information and tie it to existing knowledge. They need to organize and elaborate on information to help in encoding and creation of retrieval cues, tie to prior knowledge, and make the new information personally relevant. Guidance to elaborate may be required in a notebook where this feature is available. The combination of the encoding and external storage function of notebooks is most valuable. Learners have the ability to review organized and elaborated information in a notebook. This allows them to process the information again and assists by cuing retrieval. Generative processing research supports the use of a notebook to copy text, graphics, etc. and then add one's own elaborations. Learners can then arrange information into their own framework, be it outline or spatial map. This allows for both repetition of the information and additional processing.

The use of a notebook can be carried even further to creation of multimedia presentation. This allows the notebook to be used as an organizer for drafting such a presentation. The ideal notebook would make the transition to a finished multimedia product seamless.

Another use of the notebook would be for teacher provided questions, outlines, frameworks, or keywords. Any of these strategies can act as an advance organizer for the learner, especially those with low prior knowledge. They can provide a framework for gathering information and stimulate recall of prior knowledge. Learners could also be asked to generate their own outline or framework of prior knowledge at start to stimulate recall and provide hooks for integrating the new information. Learners could also generate their own questions to be answered at the start and fill in the blanks as they go through the program.

No matter what type of notebook is incorporated, there is a need to teach use of the learning strategy. Students using even simple notetaki: g have difficulty selecting the major concepts and including the appropriate level of detail. Many simply copy verbatim and never elaborate with their own prior knowledge, a strategy proven ineffective. Outlining and concept mapping are even more challenging. Unless the strategies are understood and carried out correctly, they will be ineffective, considered burdensome, and probably not used.

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